WILLIS HAVILAND CARRIER

Father of the Air Conditioning Industry

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Dr Willis Haviland Carrier 1876-1950

Foreword

Willis Carrier was neither the inventor of air conditioning nor was he the first to take a scientific approach to it, but he is regarded as "The Father of Air Conditioning." The earliest installation which made provision for both cooling and humidification is that of Dr David Boswell Reid in the Temporary House of Commons in 1835. However, this had been quickly erected inside the shell of the former House of Lords following the fire of 1834. The earliest building designed to incorporate what we would now call air-conditioning was St George's Hall in Liverpool. The system there, again designed by Reid, first came into use in 1851.

In 1893 the German Professor Hermann Rietschel published the basis of an engineered approach to comfort cooling. In 1901 the consulting engineer Alfred Wolff applied these principles to his design of the cooling systems for the New York Stock Exchange which featured 2100 kW of absorption refrigeration using electric generator exhaust steam. This installation recognised humidity control as a design objective. A pioneer in discovering psychrometric relationships was Stuart Cramer of North Carolina who coined the term "air conditioning in 1906.

Willis Carrier's achievements are many and in particular his vision of an entirely new industry.

Buffalo Forge & Carrier Air Conditioning Company of America

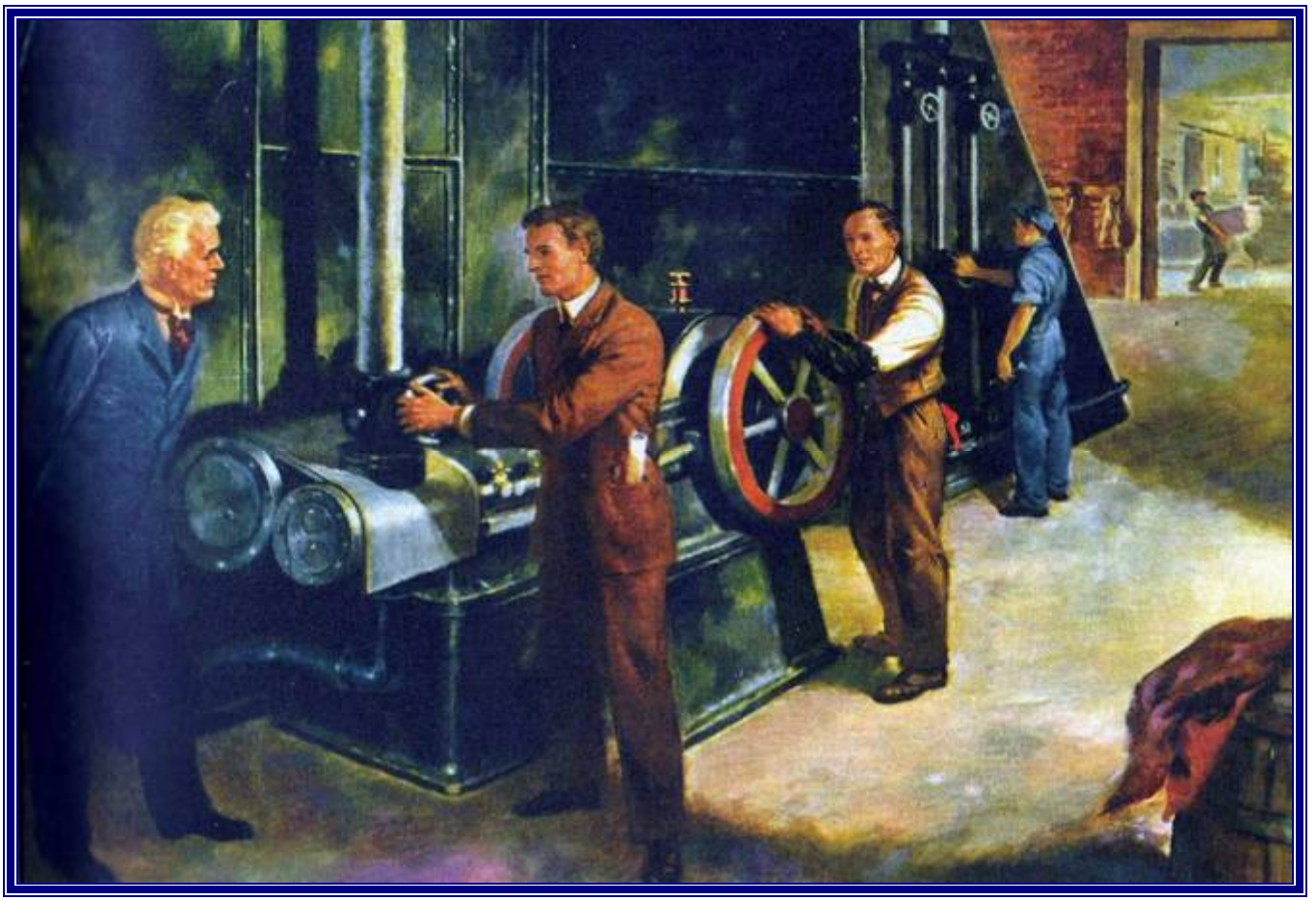
Willis Carrier was born on 26 November 1876 on a farm near Angola in New York State. His parents were farmers, life was often difficult and the future looked bleak, but in 1897 he won a four-year state scholarship to Cornell University graduating in 1901 with a degree in Electrical Engineering. Shortly afterwards he was invited by the Buffalo Forge Company for an employment interview. Carrier had intended to specialise in electricity while his prospective employers were "engaged in the manufacture of blowers, exhausters and heaters," but in July 1901 he went to work for Buffalo Forge.

Carrier soon realised that rule of thumb practises were used in designing and installing equipment leading to excessive margins of safety and cost. He set himself the task of researching existing data and produced a formula for selecting boiler fans for maximum efficiency and minimum power. This so impressed his employers that he was allowed to set up what later became an industrial laboratory.

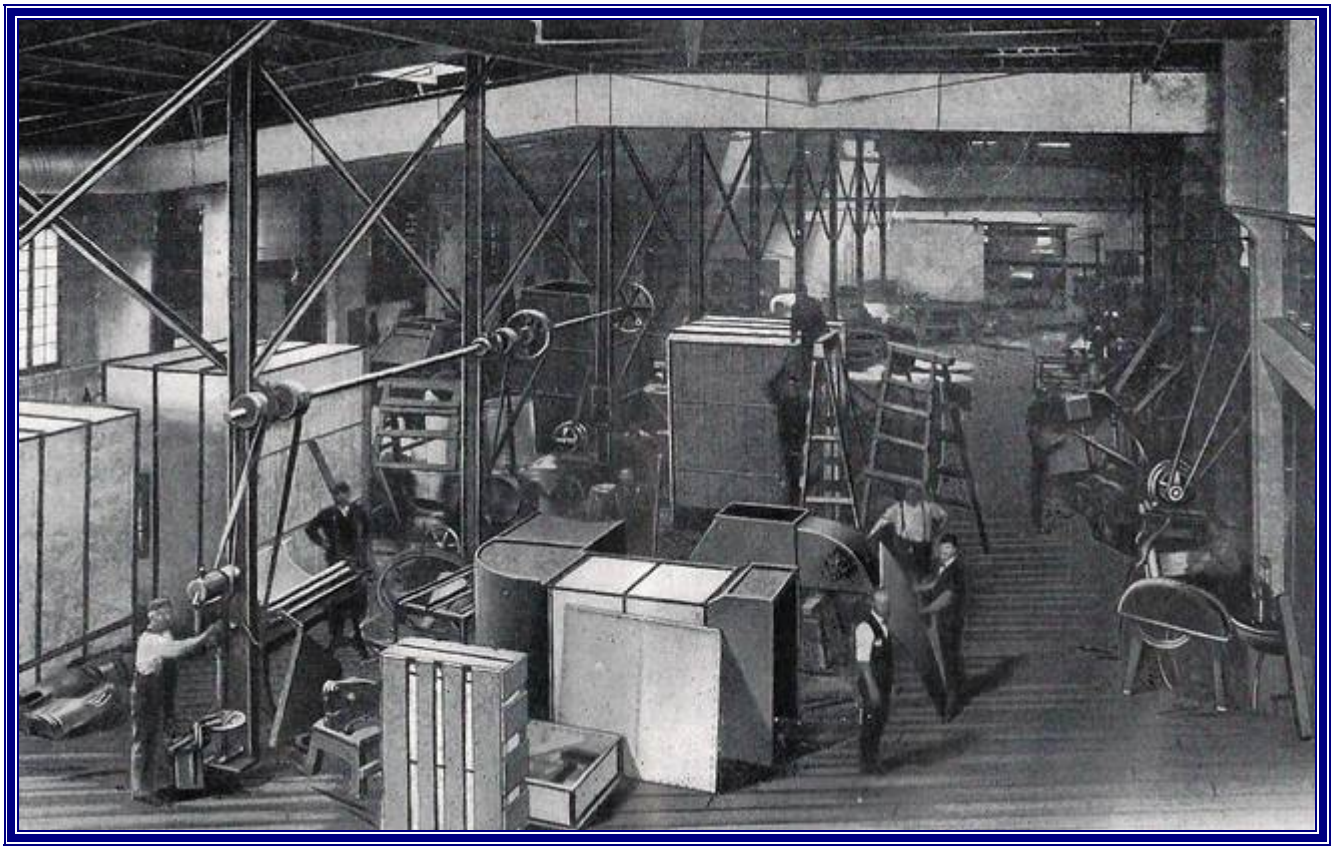
This led to the young Carrier being asked to solve the printing problems caused by atmospheric humidity variations at the Sackett-Wilhelms Lithographing Company in Brooklyn, New York. He conducted tests using his own ideas for dehumidifying air and holding its moisture content constant. This included circulating cold water through heating coils and he produced a scheme for what was then believed to be the world's first scientifically designed air conditioning system. Unfortunately, for reasons of cost, the dehumidifying coils were retrofitted to the existing heating plant and Carrier never considered the 1902 installation a success though the Advertising Department chose to ignore this (*Heat & Cold,* ASHRAE, 1997, p332). The installation was removed after a few years.

In late 1902, while waiting for a train on a foggy day in Pittsburgh he is said to have had "the flash of genius" that eventually led to dew point control. He developed the spray type washer for which he obtained a patent in 1906. While his use of spray water was readily accepted for humidifying the idea of dehumidifying air using cold water was ridiculed by many, but Carrier went on to revolutionise the textile industry. In 1907 Buffalo Forge set up a subsidiary named Carrier Air Conditioning Company of America so he could continue his work. Carrier went on to develop a constant friction method for duct sizing, invent automatic dew point controls and present his *Rational Psychrometric Formulae* in a famous 1911 paper. In 1914 the first edition of the Buffalo Forge manual *Fan Engineering* was published having taken Carrier eight years to compile.

Late in 1914, with a World War pending, the owners decided to close down its subsidiary.



Carrier (2nd from left) starts the air conditioning at the Sackett-Wilhelms plant 1902



Air washers under construction at Buffalo Forge in 1913

Carrier Engineering Corporation

On 26 June 1915 Carrier and six young colleagues pooled their resources to start Carrier Engineering Corporation (CEC) in New York. Carrier was President of the new company. By the end of the year some forty contracts had been secured. CEC, unlike their rivals, did not guarantee their installations by horsepower capacity or air volumes but by providing specified space conditions.

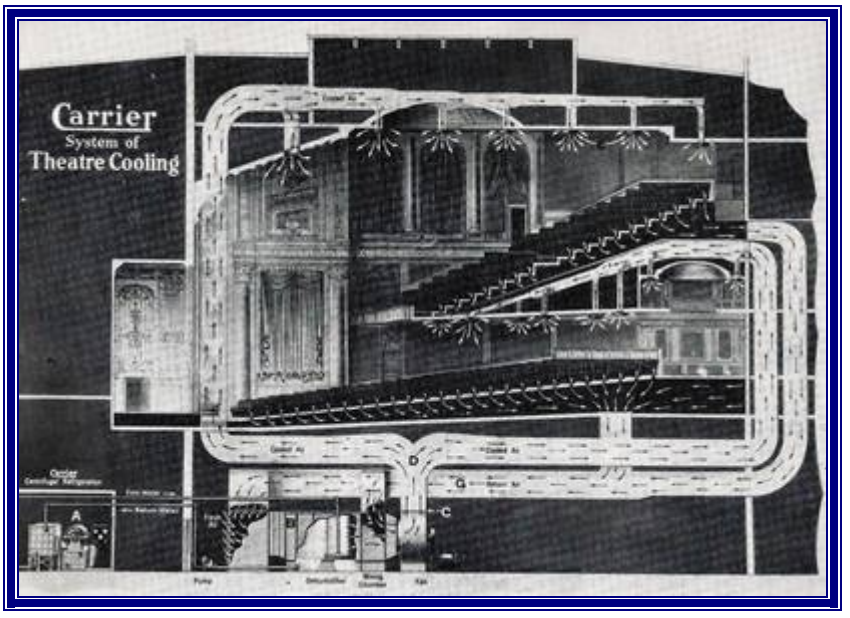
About this time Willis Carrier recognised the inadequacy of existing refrigerating machines and over the next few years visualised a centrifugal compressor with direct drive and compact heat exchangers. He lacked both a suitable refrigerant and a compressor manufacturer. In 1921 on a visit to Germany he found a compressor manufacturer and a possible refrigerant (dielene). A prototype machine was unveiled at the CEC Newark factory on 22 May 1922. By the end of 1924 nine machines had been sold.

The big break came with the opening of the "comfort" market when centrifugal systems were introduced into movie theatres. CEC went on to develop a downwards supply air distribution method and a return air bypass system of control. Further centrifugal installations included a deep gold mine in Brazil and on the warship *USS Wyoming*. In 1930 CEC provided air conditioning for the railway dining car *Martha Washington* operating between New York and Washington.

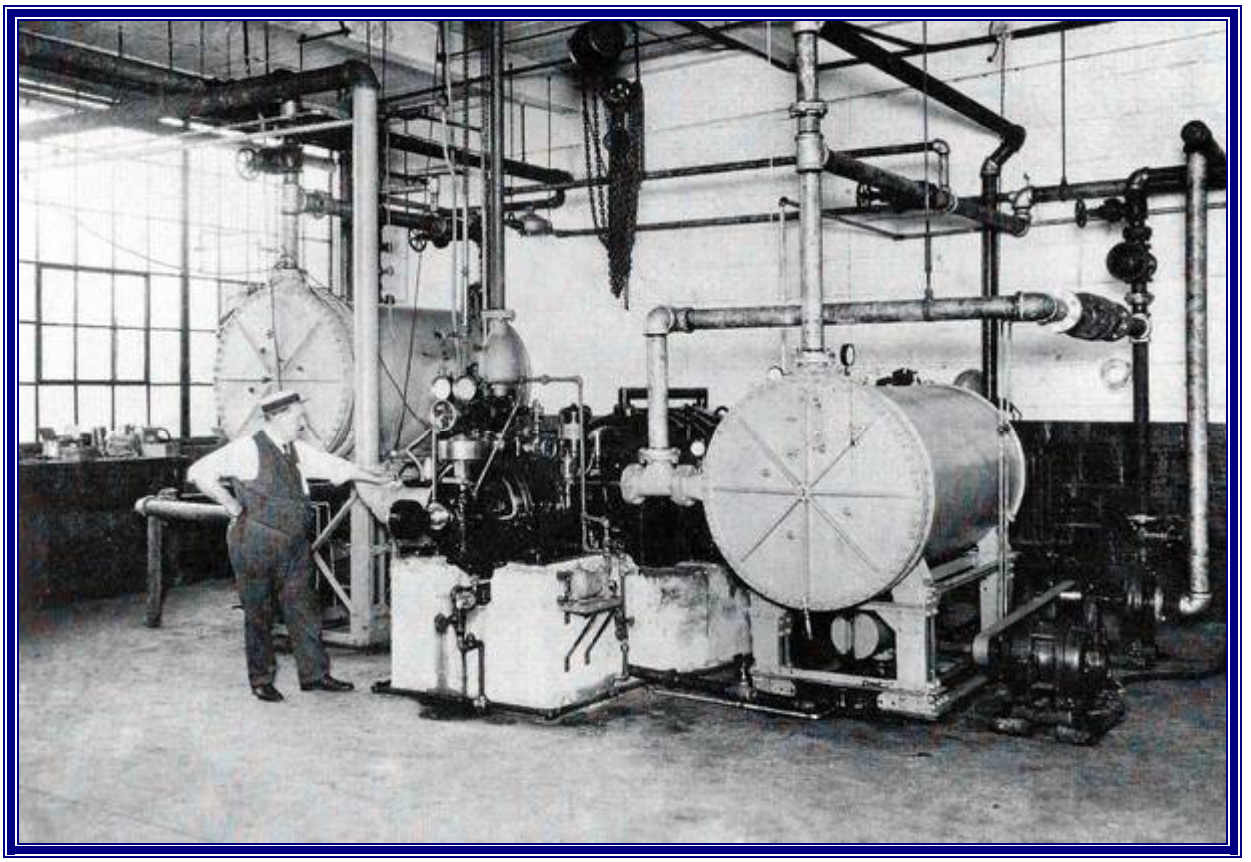
In 1930 Carrier Corporation was formed by the merger of CEC with Brunswick-Kroeschell and York Heating & Ventilation. The new Company now had to survive the Great Depression and found itself able to serve all types of buildings except one –the skyscraper. Willis Carrier solved this problem by his 1939 invention of the Conduit Weathermaster System using high velocity induction units with ejector nozzles entraining recirculation room air.

However, Carrier's greatest technical achievement is considered by many to be the system he designed for the Cleveland wind tunnel of the National Advisory Committee for Aeronautics, started in 1940 and opened in April 1944, it was required to simulate freezing high-altitude conditions for the testing of prototype aircraft. The completed installations used an air flow rate of "ten million cubic feet per minute cooled to -67 degF by fourteen refrigerating machines requiring a total of 21000 horsepower." This helped NACA win the war, but afterwards Carrier semi-retired and suffered ill health.

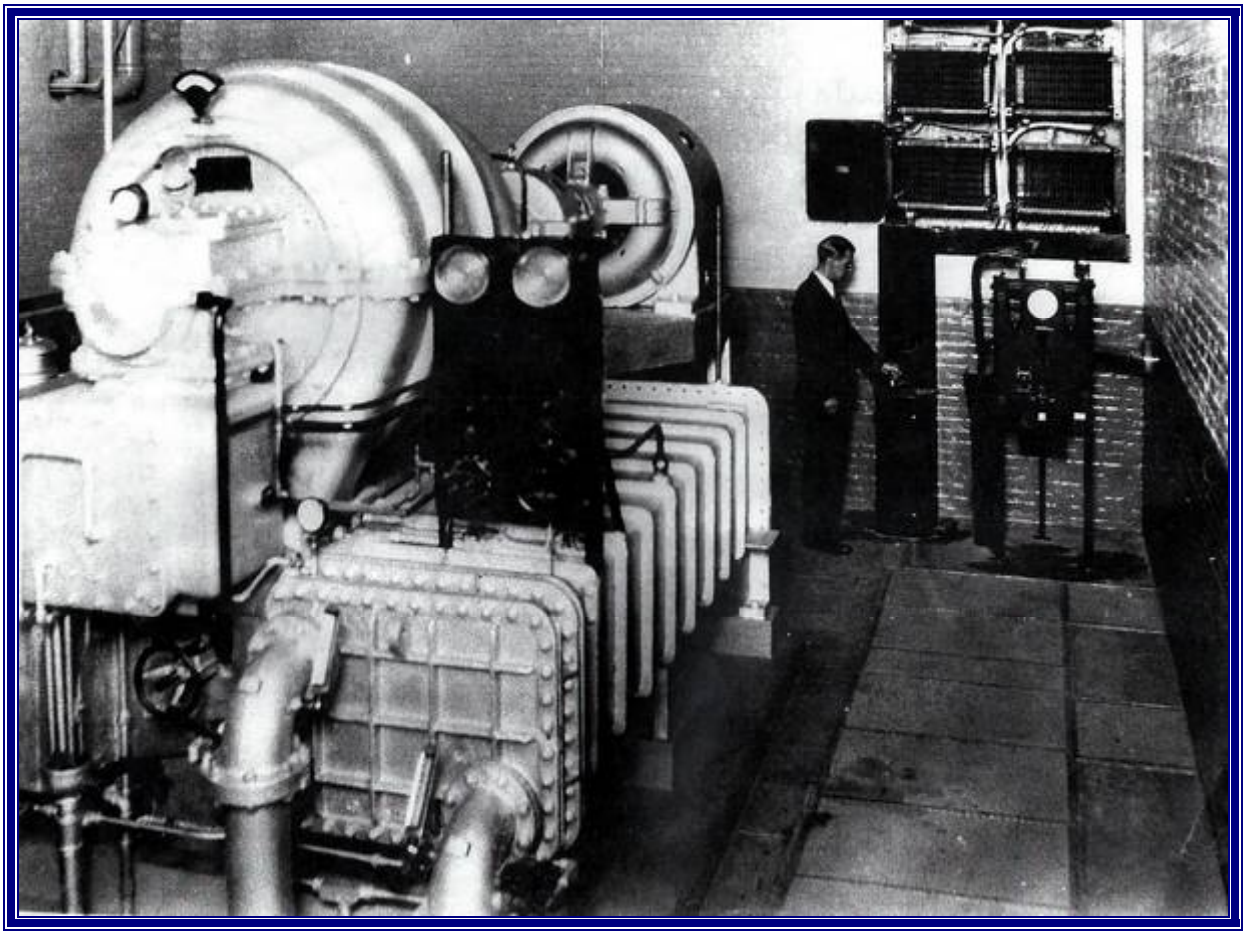
Willis Haviland Carrier died in New York on 7 October 1950 after a long and distinguished career. He was President of the American Society of Refrigerating Engineers in 1927 and of the American Society of Heating and Ventilating Engineers in 1931. He received the Franklin Institute Medal in 1941. Carrier was inducted into the ASHRAE Hall of Fame in 1994 in recognition of his significant contributions in establishing air conditioning as an industry and psychrometrics as a science.



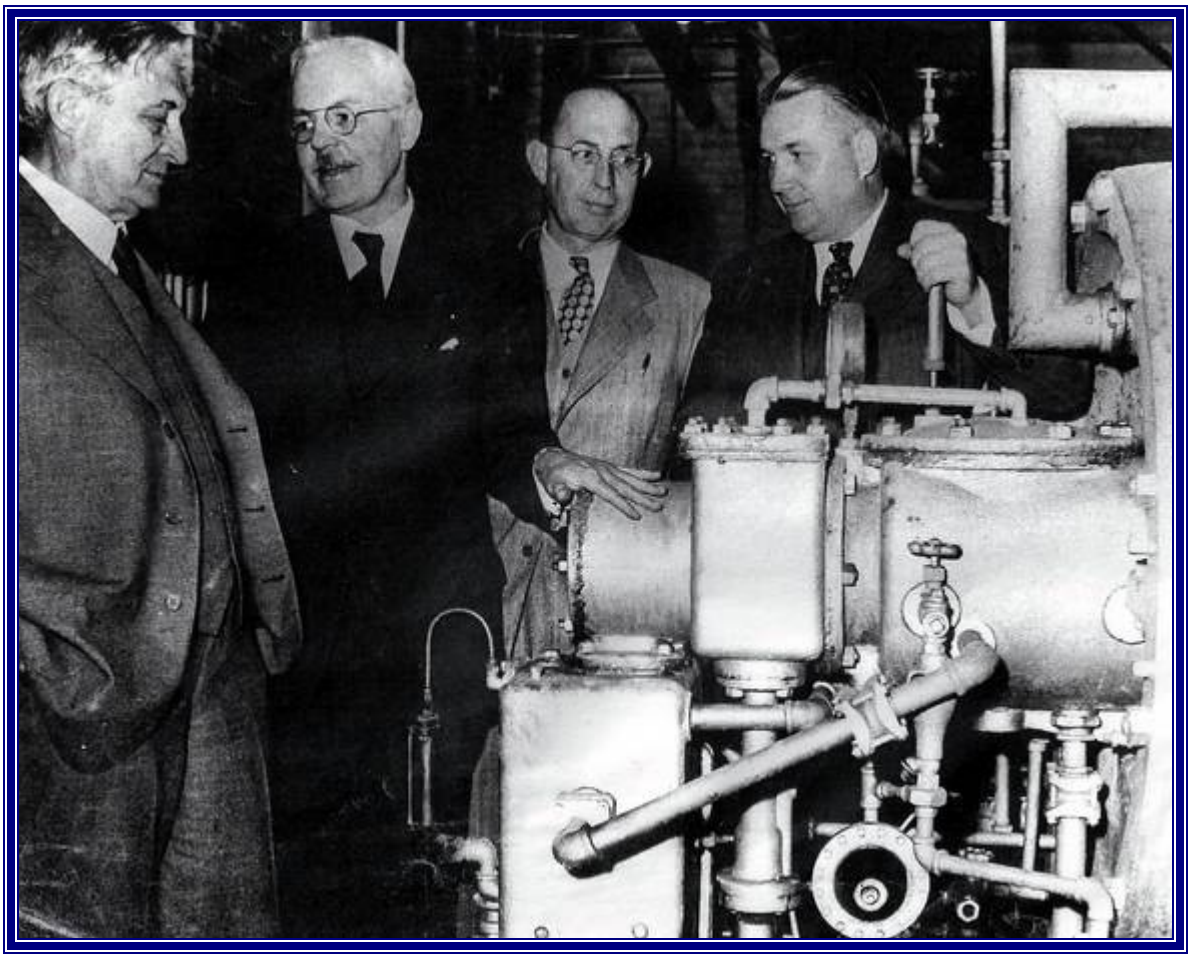
The Carrier System of Theatre Cooling with overhead supply air and return air bypass control 1922



First showing of the Carrier package centrifugal chiller at a joint ASHVE/ASRE Meeting in 1922



Carrier centrifugal chiller installed in Capitol House, Washington DC in 1928
Note the square heat exchanger



Around 1950 Carrier (left) visited the first centrifugal chiller from 1922 on show in the Smithsonian

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